Accordingly, the maximum potential interference, given calculations for four widely disparate city locations and conditions and two LMDS antennas, is at least 30.4 dB below the ambient noise (or 1 ÷ 1096 = .0009 of noise level at the NASA receiver). Since, by NASA's estimate, the interference would be sufficiently low at only 10 dB below the noise, the LMDS system yields a level of isolation that is at least 20.4 dB better than that suggested by NASA, an improvement factor of more than 110 greater than required.

CONCLUSION

In conclusion, Io/No at the NASA satellite receiver is a minimum -30 dB, even using the NASA assumptions. Thus, LMDS cannot interfere with NASA.

ADDITIONAL POINTS OF CLARIFICATION

There are additional points made in the NASA Document which require clarification. These are listed and discussed below:

1. (Page 17) "The cost of implementing cable heads in each and every cell or, alternatively, of distributing signals from a single source to each cell casts doubt about the economic viability of LMDS."

   However, in the LMDS solution, point-to-point direct (or intermediate repeated for non-line-of-sight) microwave links cross connect all cell nodes. This is accomplished simply by using a directional coupler which samples the master (node A) transmitter. The sampled signals are amplified and passed to a high gain parabolic antenna with 35-40 dB gain at the same polarization as incident to the cell. Adjacent cell receivers amplify and repeat again but change to the orthogonal polarization. There is also an opportunity at these repeaters to add or delete programming material, a unique characteristic of the LMDS system, which allows for customized demographic programming, shopping, local advertising and various forms of interactivity. The repeaters do not significantly detract from the video quality due to the analog FM modulation scheme employed. This form of repeater backbone has been demonstrated in the implementation of LMDS in Brighton Beach, New York.

2. (Page 17) "It would appear that it would be difficult, at best, to find feasible sites for many towers that would be required and that public resistance to siting of these towers could be intense."

First, the LMDS antenna can be as small as 2 square inches to a maximum 4 square feet, hardly intrusive enough to elicit public resistance. The antenna is served by a connecting wave guide of only 0.3" by 0.15" cross section, of whatever length is required. This wave guide can be enclosed within a 1 to 4.5 inch diameter, hollow mounting pipe. The actual transmitter is similar in size to a large suitcase and can be mounted either on the top of the building beneath the antenna or contained in a small closet or enclosure within a building below roof level. Roof space, aside from the World Trade Center, is readily available at very low cost throughout New York and other areas via the "Antenna Site Locater" book, and, for an object as unobtrusive as an LMDS transmitter at very modest cost.

3. (Page 19) "Polarization discrimination would be virtually non existent because the coupling between the LMDS antenna and the earth station antenna would occur through a sidelobe or backlobe of the FSS earth station antenna or the LMDS antenna."

As implied in 2. above, NASA appears to be unfamiliar with basic patch (phased array) antenna design at millimeter waves (Figure C) to be used by LMDS. Note that the vertical to horizontal (V-H) isolation is a minimum of 37 dB throughout 360° and typically as much as 44 dB.

4. (Page 22) "[I]f an LMDS system is implemented that is later found to have insufficient margin..."

The Sarnoff report (page 22, Appendix B of Reference 3) contains a table which reveals that the rain fade causes a carrier-to-noise ratio (C/N) deterioration of 13.4 dB, resulting in a video signal-to-noise ratio (S/N) equal to 42 dB (Grade 3.3), which is 4.4 dB above zero deviation threshold (page 13). Moreover the actual rain fade by CCIR tables (Reference 7, pages 633 and 742) is 13.8 dB. Accordingly, there is a minimum margin of 5.6 dB. This is quite good, considering the fact that intense rainfall is generally limited to small areas. The LMDS margin in fringe areas during clear days is nearly 20 dB!

5. (Page 16) "Fade margins of 30 dB could be required in clear weather and in excess of 30 dB in rain."

This assertion is inaccurate. Since LMDS is cellular, and the transmitter is at the cell center, rain fall attenuation is calculated along the radius only, not the cell diameter. Thus, a 6 mile diameter cell in New York has a radius of only 3 miles, and 3 miles x 4.6 dB/mile (per the CCIR Handbook) = 13.8 dB fade by CCIR calculation and 15.O dB fade by satellite calculations. This is far from 30 dB.

Clear weather fade, due to inhomogeneity of the atmosphere, is calculated by the classic Barnett-Vignant reliability equation (page 97 Reference 8) as:

Fade Margin $= 30 \log a + 10 \log (6ABf) - 10 \log (1\text{-}R) - 70$

where

$1\text{-}R$ = reliability

A = roughness factor

= 4 for very smooth terrain

= 1 for average terrain

= 1/4 for very rough terrain

B = 1 for worst month

= 1/2 for hot humid areas annual probability

= 1/4 for average areas annual probability

= 1/8 for dry areas annual probability

Typical clear weather fade margin is less than 3 dB.

The important point to keep in mind is that clear weather fade cannot be added to rain fade. By definition, during rainfall the atmosphere is homogenous and atmospheric fade, due to inhomogeneities, is not present. In the LMDS design, to be conservative, the larger of the two fade margins is employed.

References

1. Comments of The National Aeronautics and Space Administration CC Docket No. 92-297, RM 7372, March 16, 1993.

2. Reply Comments of Suite 12 Group, CC Docket No. 92-297, April 15, 1993, Appendix 4, An Analysis of Uplink LMDS Interference to the NASA ACTS Satellites, April 11, 1993.

3. Suite 12 Group Petition for Rulemaking, September 23, 1991.

4. "Linear Amplifier Combines," Johnson and Myer, AT&T Bell Laboratories, 1987 IEEE.

5. "Investigation of Multiple FM/FDM Carriers Through a Satellite TWT Operating Near to Saturation," Westcott and Eng, IEEE 1967 June.

6. "World Book Encyclopedia."

7. "Reference Manual for Telecommunications Engineering," Roger Freemen, John Wiley & Sons.

8. "Digital Communications," Feher, Prentice Hall.

Figures

Appendix

System Antenna Coverage

ACTS

The ACTS multibeam antenna system provides electronically controlled high-gain spot beams and is a key technology to be validated as part of the ACTS flight system. The multibeam antenna system consists of separate transmitting and receiving offset Cassegrain antennas, each with a dual, gridded subreflector in a piggyback configuration. The 30-GHz receiving antenna is 2.2 m in diameter; the 20-GHz transmitting antenna is 3.3 m in diameter. The antenna diameters are scaled so that the gains and spot beam sizes are the same for both uplink and downlink beams. The expected nominal ranges of gain-to-noise-temperature ratio and effective isotropic radiated power are given in table I. The transmitting antenna's main reflector is equipped with a two-axis drive that allows vernier

TABLE I.—SUMMARY OF ACTS LINK BUDGET
[Values subject to change as design is stabilized.]

Beam	Receiving polarization[a]	Receiving	Transmitting	Spacecraft effective isotropic radiated power, dB	Spacecraft gain-to-noise-temperature ratio, dB/K
		Gain (at edge of coverage[b]), dB			
East family					
East scan sector	Horizontal	[c]47.7	[c]46.8	59.6	17.0
Houston	↓	50.8	50.6	62.9	19.2
Kansas City	↓	50.8	50.7	63.8	19.4
Los Angeles–San Diego	↓	49.2	48.1	60.4	17.1
Miami	↓	50.6	50.2	62.6	18.9
Nashville–Huntsville	↓	50.9	50.8	63.0	20.0
Seattle–Portland	↓	49.1	48.3	60.6	17.8
West family					
West scan sector	Vertical	[c]46.1	[c]47.1	59.4	16.0
Dallas	↓	49.2	50.6	62.6	18.0
Denver	↓	48.9	50.2	62.3	17.7
Memphis	↓	49.5	50.9	63.0	18.1
New Orleans	↓	49.3	50.8	63.8	18.1
Phoenix	↓	48.6	48.8	61.0	17.5
San Francisco	↓	48.1	46.1	57.9	16.8
White Sands	↓	48.9	49.8	62.1	17.7
Steerable	↓	----	----	55.6	----
Stationary beams					
Cleveland	Horizontal	50.5	51.3	[d]57.8/64.0	20.1
Atlanta	Vertical	50.8	51.4	[d]57.8/64.0	19.5
Tampa	Vertical	50.0	51.0	[d]57.4/63.7	19.8

[a]Transmitting polarization is orthogonal to receiving polarization.

[b]Edge of coverage for spot beams is defined as 0.27° beamwidth and is nominally 2 dB less than peak gain.

[c]Minimum scan sector gain.

[d]Ratio of low-power to high-power modes.

adjustments of the boresight to align it with the receiving antenna. The front subreflector is gridded to pass one sense of polarization and reflect the orthogonal polarization. The back subreflector is solid and reflects the polarization transmitted by the front subreflector. The focal axes of the two subreflectors are tilted with respect to the main reflector's plane of symmetry so that the two orthogonally polarized feed assemblies (east family and west family) can be placed side by side without mechanical interference. Compact, conical, multiflare horns formed by three flared waveguide sections are used for the fixed and isolated spot horns. To meet the stringent spacecraft pointing requirements (0.025°), the receiving antenna will have a monopulse tracking capability associated with the Cleveland fixed beam.

ACTS will employ two hopping spot beam families and three fixed beams for both transmitted and received signals (fig. 3). The beams will provide the coverage shown in figure 8. The hopping beams will be programmed to visit only those areas with traffic for any given experiment scenario. The hopping beams, designed primarily for the baseband processor operating mode, consist of two independent uplink and downlink beams (four beams total) providing simultaneous coverage at the same frequency. The half-power beamwidth of these spot beams is approximately 0.33°, covering roughly a 135-mile diameter. One uplink-downlink beam combination covers the east hopping beam family and the other covers the west hopping beam family. The east family consists of (1) an east scan sector—contiguous areas in the eastern portion of the United States and (2) six isolated spots covering Miami, Nashville–Huntsville, Houston, Kansas City, Seattle–Portland, and Los Angeles–San Diego. The west family

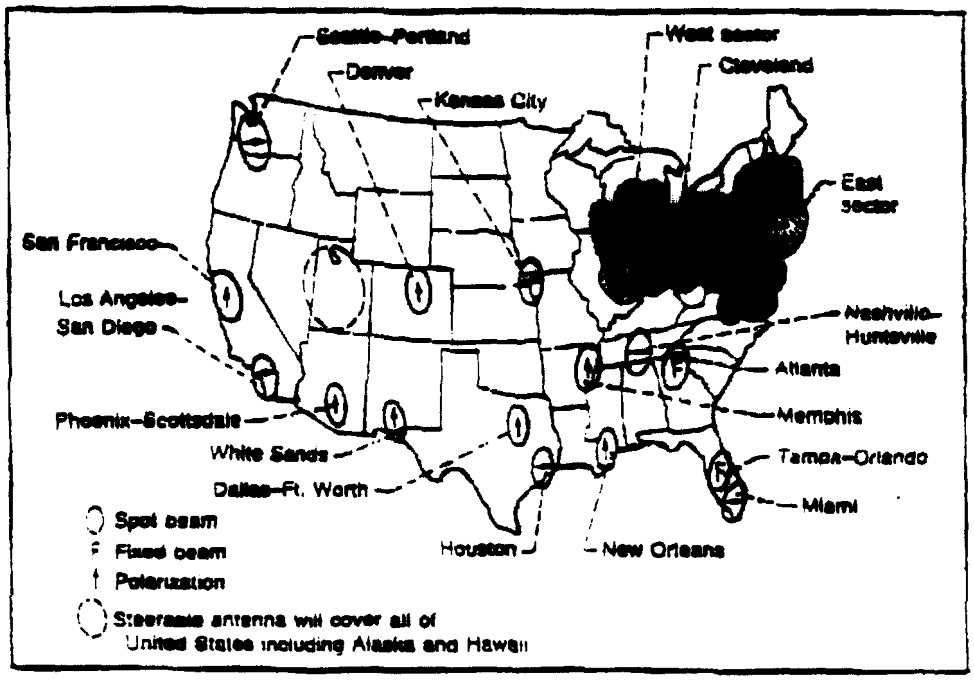


Figure 8.—ACTS multibeam antenna coverage. (ACTS at 100° west longitude.)

ACTS Parameters

Frequency Bands

Uplink 29.0 - 29.9 GHz
Downlink 19.2 - 20.1 GHz
Downlink Beacons at 27.505, 20.185, and 20.196 GHz
Uplink Beacon at 29.975 GHz

Antenna size

Low burst rate terminals LBR-2: 1.2 m and 2.4 m
NASA Ground Station NGS in Cleveland: 5 m
High burst rate terminals HBR: 4 - 5 m

Transmission Rates and Bandwidth

<u>LBR-1:</u>
Uplink 110.592 Msps with no coding (55.29 Msps with rate 1/2 coding)
165.88 MHz carrier Bandwidth, center frequency at 29.236 GHz
Downlink 110.592 Msps
165.88 MHz bandwidth, center frequency at 19.44 GHz

<u>LBR-2:</u>
Uplink 27.648 Msps with no coding (13.3 Msps with rate 1/2 coding)
41.472 MHz carrier bandwidth, center frequencies at 29.291 and 29.236 GHz
Downlink 110.592 Msps
165.88 MHz bandwidth, center frequency at 19.44 GHz

<u>HBR:</u>
Uplink 500 Msps, 750.0 MHz carrier Bandwidth, center frequency at 29.420 GHz
221.18 Msps, 331.77 MHz Bandwidth, center frequencies at 29.160 and 29.680 GHz
Downlink 500 Msps, 750.0 MHz carrier Bandwidth, center frequency at 19.70 GHz
221.18 Msps, 331.77 MHz Bandwidth, center frequencies at 19.440 and 19.960 GHz

EIRP

LBR-2 1.2 m: ~ 60 dBW
LBR-2 2.4 m: ~66 dBW
HBR: ~75 dBW

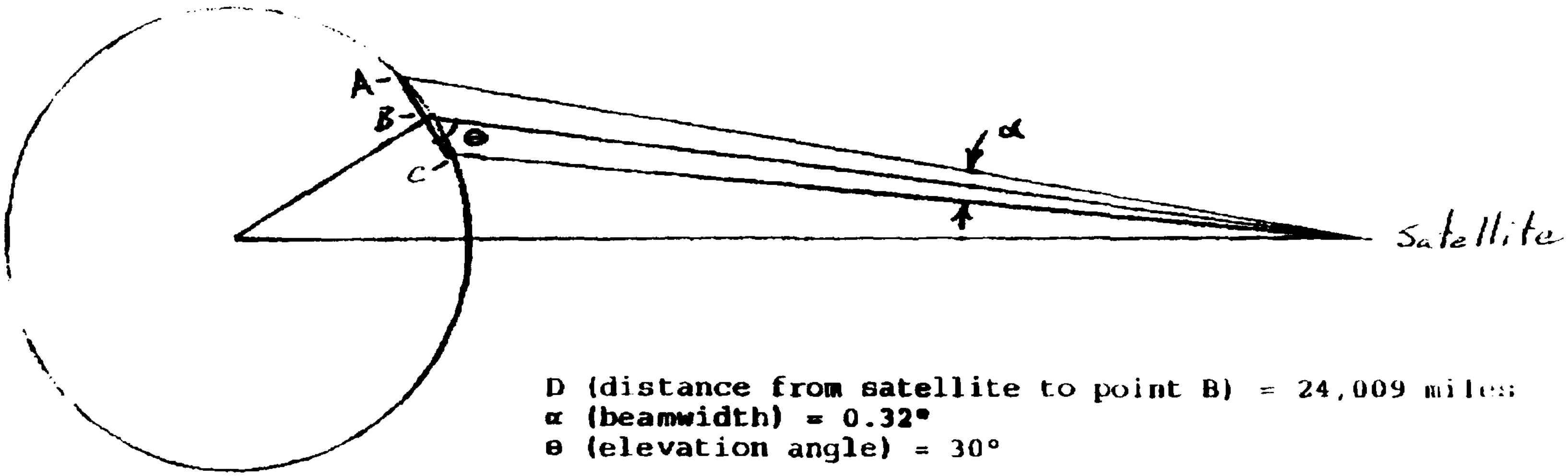
Elevation Angles

Satellite @ 100 deg West

New York: 35.9 deg.
Seattle: 31.2 deg.
Los Angeles: 45.8 deg.
Miami: 52.6 deg.

Coverage & Satellite EIRP

See attached.



D (distance from satellite to point B) = 24,009 miles
α (beamwidth) = 0.32°
θ (elevation angle) = 30°

Assume that footprint of the beam will be an elipse.
AC is the long axis of the elipse. We can also assume that $\overline{AB} \sim \overline{BC}$
In $\triangle ABS$ $\angle ASB = 0.16°$
$\angle ABS = 180° \quad \theta = 150°$ then,
$\angle SAB = 180° - 150° - 0.16° = 29.84°$
Now using sinuses theorem we will have $\frac{\sin 0.16°}{AB} = \frac{\sin 29.84°}{D}$.

Then $AB = D \frac{\sin 0.16°}{\sin 29.84°} = 24{,}009 \text{ mi.} \times \frac{2.793.10'}{0.4976} \sim 135 \text{ mi.}$

The short axis of the elipse will be equal $D \operatorname{tg} \frac{x}{2} \sim 67$ mi.

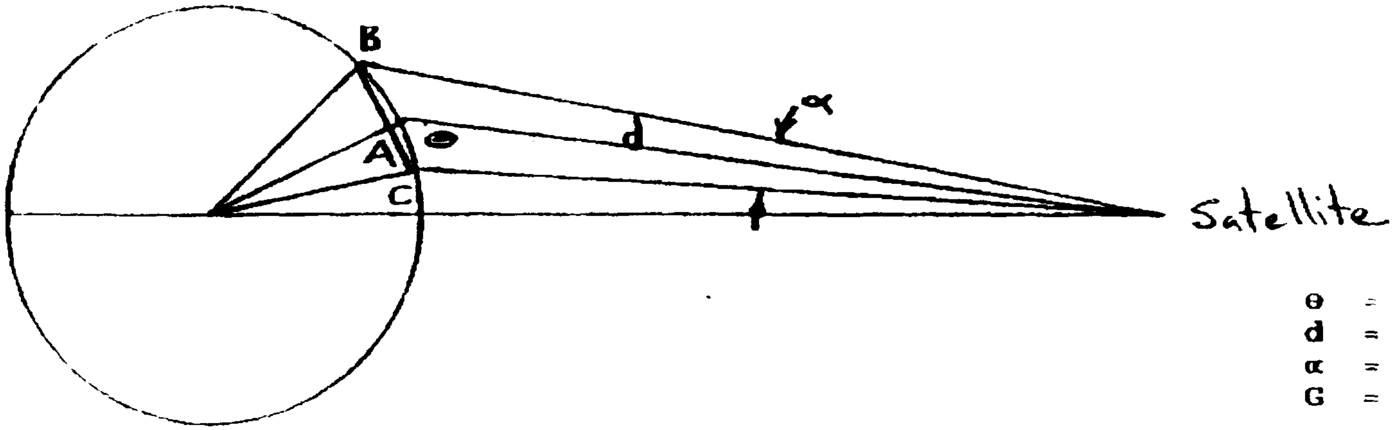
So area of footprint $S = ab = 3.14 \times 135 \text{ mi.} \sim 28{,}415 \text{ mi.}^2$ (a,b axis of elipse)

Distance D	Elevation Angle θ	Gain G	Beamwidth x	Footprint Area
24,009 mi.	30°	53 dB	0.32°	28,415 mi.^{2}
1,500 mi.	30°	28 dB	7°	26,015 mi.^{2}
1,500 mi.	10°	28 dB	7°	*56,360 mi.^{2}

* Calculations for that area used more accurate calculations

APPENDIX 3

NASA Geostationary Satellite Footprint 32 dB antenna



$\theta = 30°$
$d = 24{,}009$ miles
$\alpha = 4.2°$
$G = 32$ dB

$$< BSA = \frac{\alpha}{2} = 2.1°$$

$$< BAS = 180° - \theta = 150°$$

$$< ABS = 180° - 150° - 2.1° = 27.9°$$

$$< ACS = 180° - \theta - 4.1° = 147.9°$$

In Δ BAS we have $\dfrac{BS}{\sin < BAS} = \dfrac{d}{\sin < ABS}$ x $\dfrac{BS}{\sin 150°} = \dfrac{d}{\sin 27.9°}$ =>

$BS = 25{,}655$ miles

In Δ BCS $\dfrac{\sin \alpha}{BC} = \dfrac{\sin < BCS}{BS}$ =>

$$BC = BS \frac{\sin \alpha}{\sin 147.9°} = 25{,}655 \times \frac{\sin 4.2°}{\sin 147.9°} \sim 3{,}536 \text{ miles}$$

Assume that footprint is an elipse

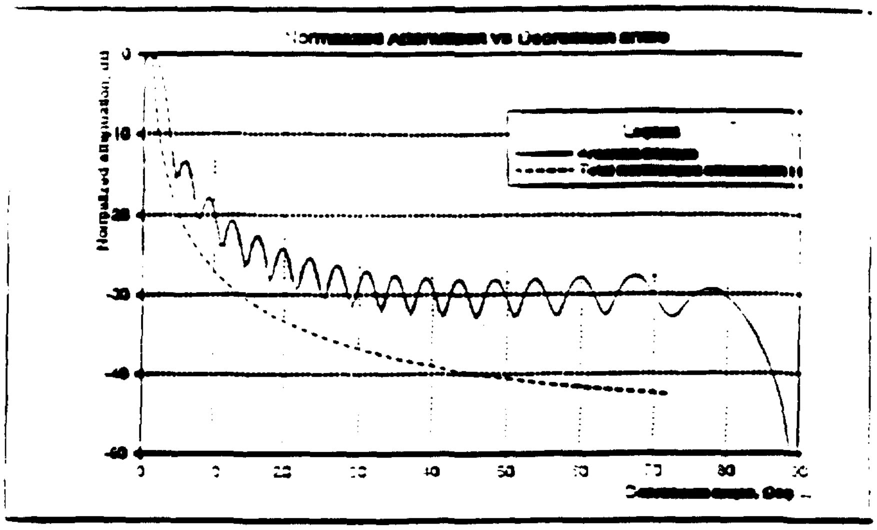
$$a = \frac{BC}{2} = 1{,}768 \text{ miles}$$

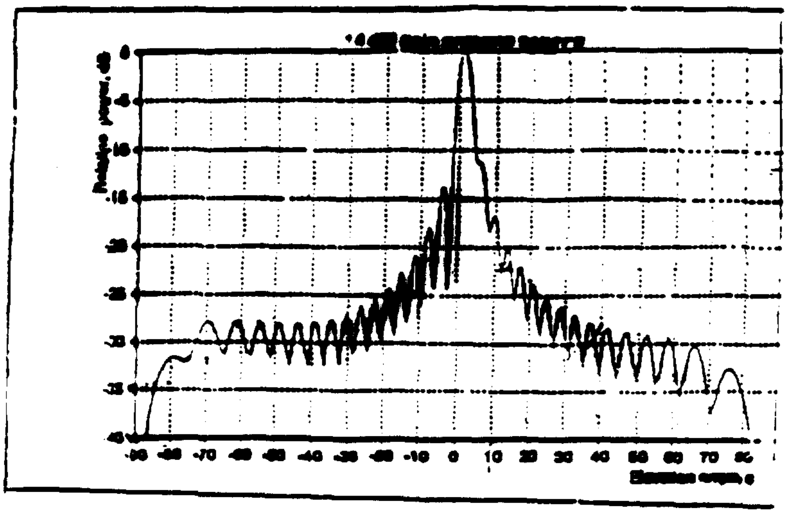
$$b = D \, tg \frac{\alpha}{2} = 880 \text{ miles}$$

$S = \pi ab = 4{,}889{,}870$ miles^2, so it will cover U.S.

FIGURE A

TRANSMITTER ANTENNA GAIN PATTERNS





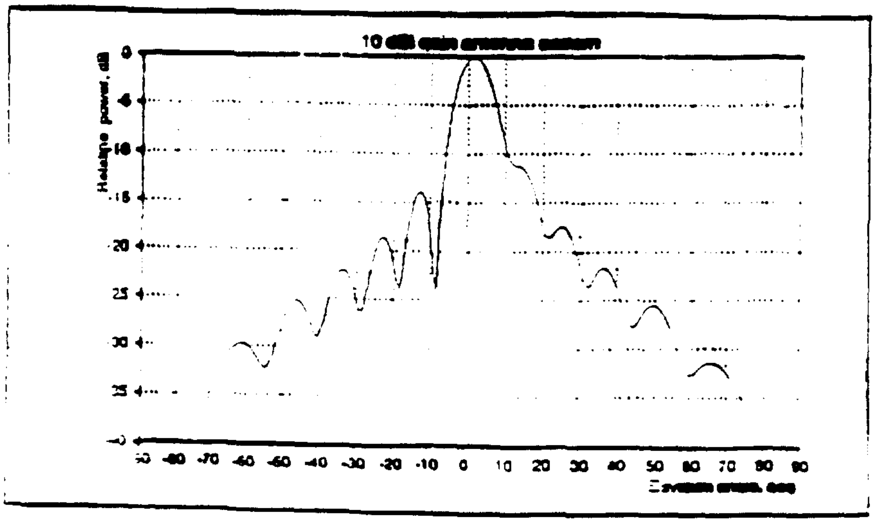
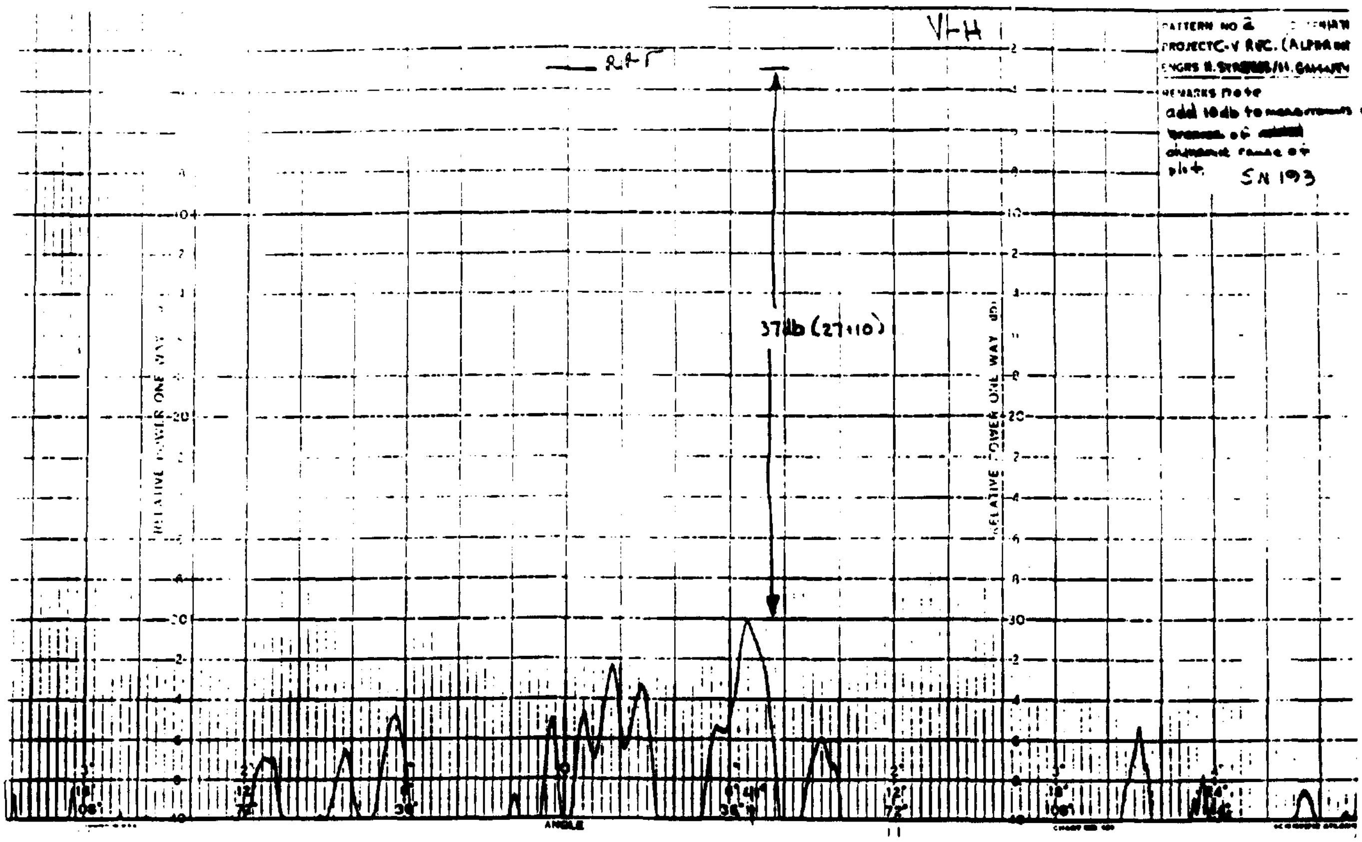


FIGURE B

RECEIVER ANTENNA GAIN PATTERNS



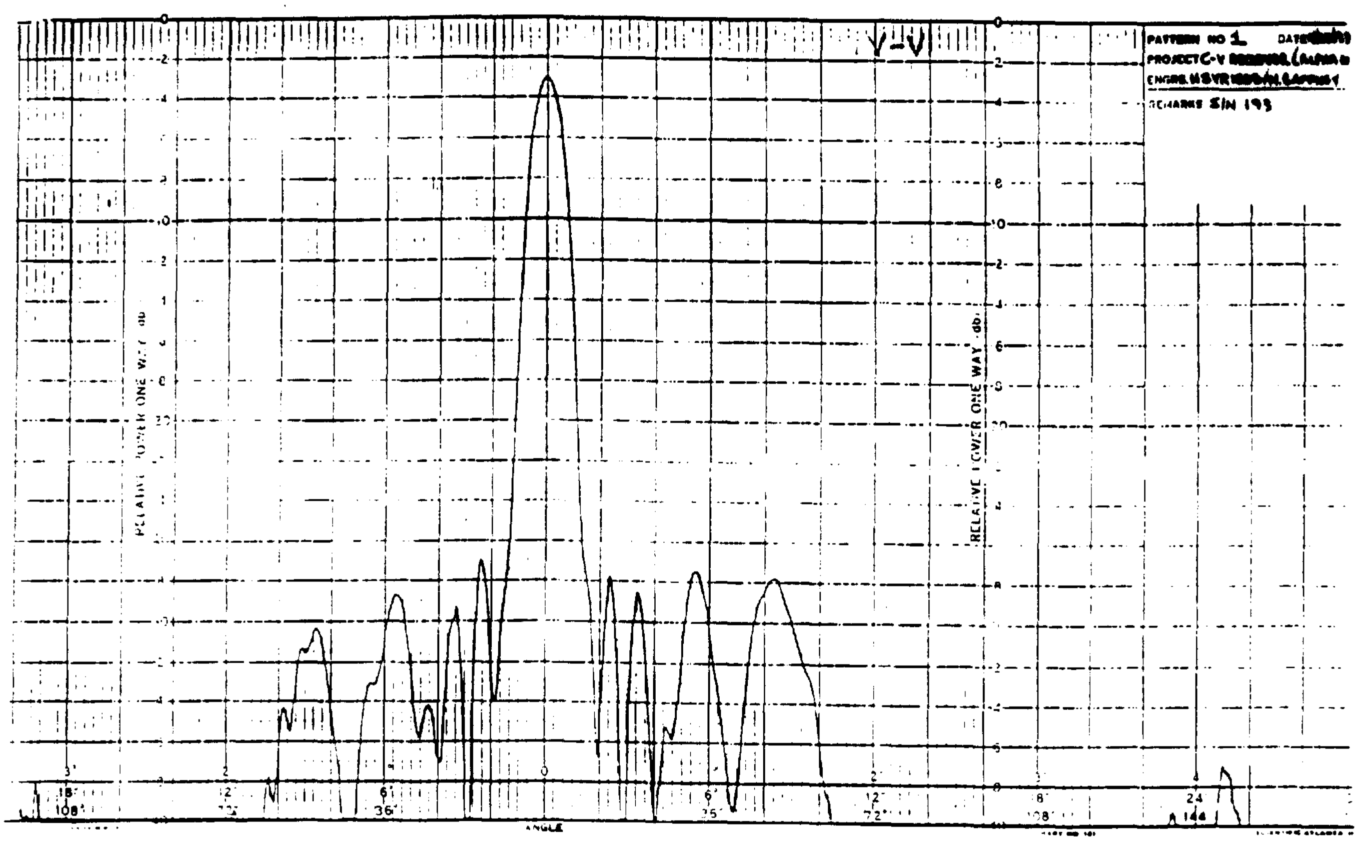
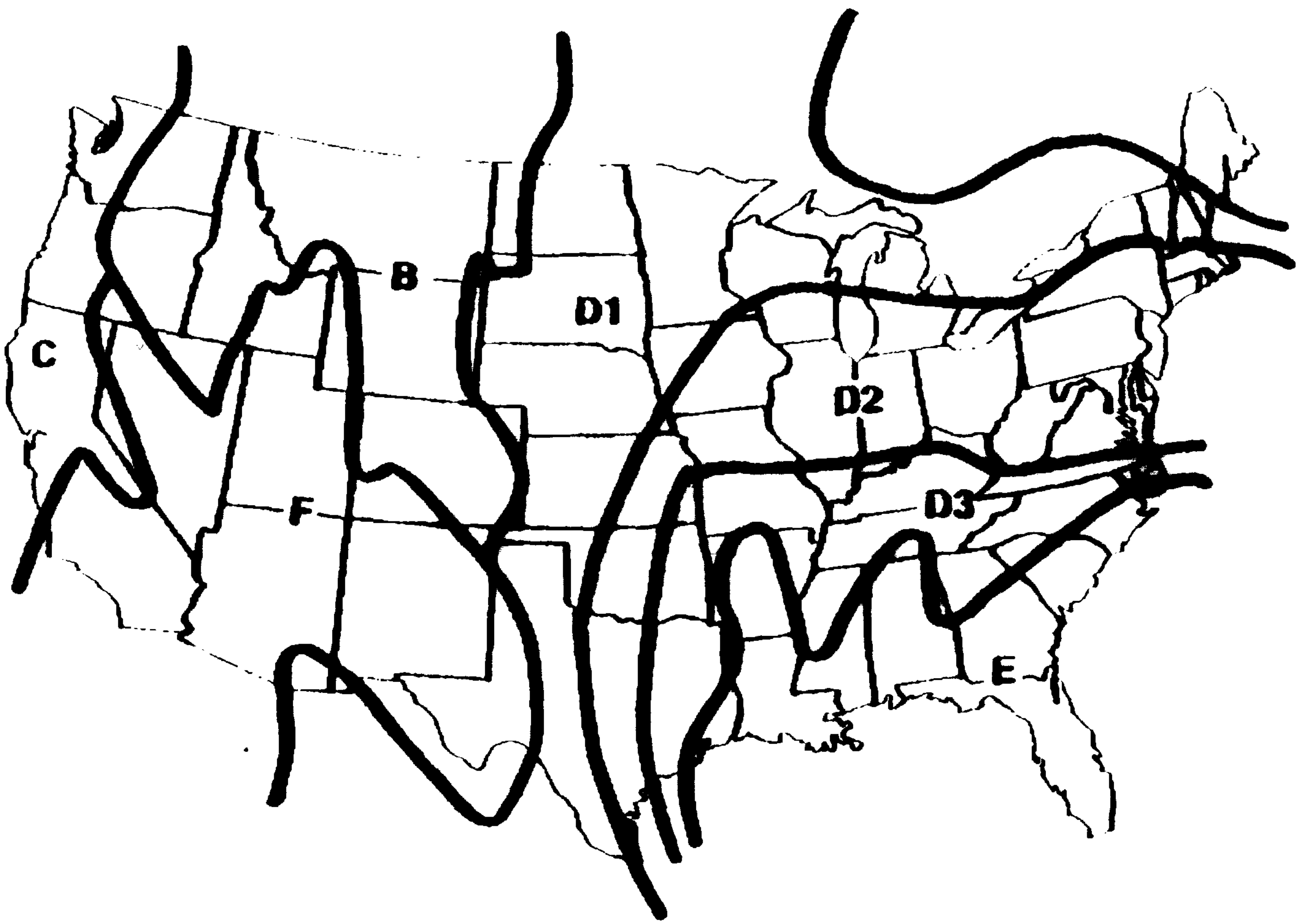


FIGURE C

GEOGRAPHIC REGIONS OF SIMILARITY IN RAINFALL STATISTICS
(From Crane and CCIR)



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November 22, 1993

By Hand

RECEIVED
NOV 2 2 1993
FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Mr. William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, NW
Washington, DC 20554

Re: Ex Parte Presentation
CC Docket No. 92-297

Dear Mr. Caton:

On behalf of Suite 12 Group ("Suite 12"), petitioner in the above-referenced rulemaking proceeding, enclosed please find two (2) copies of a report prepared by engineer-inventor Bernard B. Bossard regarding the positive benefits which accrue to the public from the availability of wideband communications services.

The report reiterates why the prudent allocation of the 28 GHz spectrum band for Local Multipoint Distribution Service ("LMDS") for the provision of video, voice and data services is in the public interest. Importantly, with the allocation of two 1 GHz blocks of spectrum per service area, LMDS will offer an immediate competitive alternative to cable television throughout the United States.

In addition to the role of LMDS as a viable alternative to cable, the report further details how the wideband allocation for LMDS can offer a number of other significant and beneficial services to consumers, including public service broadcasting and narrowcasting, education, health care, small business use, large business use, expansion of internet and the information highway, entertainment and a variety of additional services.

Please place these two copies of this report in the above-referenced docket. Questions regarding this report should be directed to the undersigned.

Sincerely,

Michael R. Gardner

Michael R. Gardner
Charles R. Milkis
Counsel for Suite 12 Group

Enclosures

cc Thomas Tycz, Deputy Chief, Domestic Facilities Division
Robert James, Chief, Domestic Radio Branch
Harry Ng, Senior Engineer, Satellite Radio Branch
Susan E. Magnotti, Esq.

THE NEED FOR WIDEBAND SERVICES

by

Bernard B. Bossard

SUMMARY

This paper describes the various reasons why the allocation of the 27.5-29.5 GHz band for Local Multipoint Distribution Service (LMDS) for bilateral distribution and reception of video, voice and data services is in the public interest.

The immediate and primary need for this bandwidth, to accommodate two competing services of a minimum 1 GHz bandwidth each, is to provide an alternative to the current television cable distribution system having the same bandwidth capacity. Moreover, the allocation of 1 GHz bands each to two licensees per service area engenders competition within the LMDS approach itself, insuring from its inception its responsiveness to the consumer market, and providing alternatives for the public whom it serves.

The LMDS needs an equivalent bandwidth in order to be able to compete on an equal basis with cable, offering the rich diversification of services which include not only entertainment, but public service broadcasting & narrowcasting, education, health care support, small & large business use, and communication with the Internet & "information highway."

These areas of public service are examples of the rich legacy of communication benefits that can be provided by LMDS to the general public provided that this promising new service is allocated sufficient bandwidth, i.e. at least 1 GHz per licensee, to compete with the present and entrenched cable delivery system of services.

INTRODUCTION

Communications capabilities are an intimate facet of our society. The development of the telephone played a pivotal role, enabling the growth of cities and large corporations, by reducing the need for face-to-face communications in human interactions. However, there remain many instances in which the limited bandwidth of the telephone, and hence its limited functionality, simply is inadequate to replace the visual information transfer that occurs with face-to-face communication.

The future availability of affordable high bandwidth communications capabilities can serve in many more instances as an acceptable substitute for face-to-face communications. This can be expected to have as dramatic an effect in the coming decade as did the introduction of the voice telephone in the early part of the 20th century.

The range of activities which can be facilitated today by the availability of wide bandwidth, affordable communications capabilities ranges from public service broadcasting and narrowcasting, to education, health care, small and large business use, as well as the expansion of Internet & the "information highway", entertainment and a variety of additional services.

In this paper we omit the general "entertainment" industry. Its needs are well known and its desirability by the public sufficiently understood, particularly the public interest need of providing consumers with an alternative means of video service to cable television.

Rather, the focus of this paper is on the non-entertainment opportunities which become accessible by widely available, low-cost, bi-directional communications. The point is not that entertainment benefits are unimportant, but rather that there are a whole host of additional positive benefits which accrue to the general public when bi-directional wideband communications become economically available to everyone. The result is efficient management of the spectrum for the public good, benefitting the greatest number of individuals.

Six specific application areas are discussed in this paper to show briefly how they can benefit the two-way video, audio and data communications afforded by wide bandwidth communications. This list is not exhaustive. Rather it constitutes the most beneficial and presently known applications of integrated wideband communications as, historically, communications evolve to be more complex and encompassing than first realized. For example, the current widespread use of FAX transmissions was hardly envisioned during the early introduction of the telegraph and telephone. Also, cellular telephone usage has surpassed all previously made.

PUBLIC SERVICE BROADCASTING & NARROWCASTING

The currently available methods for providing information to communities use either the allocated portions of the radio spectrum or cable television coaxial cable delivery. The former is a scarce resource in the lower frequency portion of the spectrum, and inherently "non-local" because the signal range of low frequencies is so vast. Similarly, the cable television infrastructure is generally a privately owned, large corporate asset not oriented to community service. By contrast, cellular high bandwidth radio communications, which can be designed for the 27.5-29.5 GHz range, offers the prospect of more affordable communication capabilities which can, by virtue of their relatively small cell size and high information transmission capacity, provide both information and entertainment services on a community by community basis. The comparatively low cost of non-digital, analog receivers for such systems, and the fact that a huge capital infrastructure need not be created to provide service, portends well for the availability of community services at more easily afforded rates.

Community service can include the provision of ethnically or culturally oriented programming. This may be considered within the scope of entertainment, although the small target audience and confined material content helps to preserve ethnic diversity, a heritage, and a service to the public which goes beyond entertainment.

Just as there has been a trend at the national level to make government more accessible to the general public by broadcasting House and Senate proceedings, along with a host of regulatory processes ranging from Ethics Committee hearings to FCC meetings and hearings, the full range of state, city and local government processes can be made more accessible by wideband communications. Indeed, this public enlightenment is a cornerstone of our democracy.

EDUCATION

There is a major and unfilled need to provide retraining across a broad range of industries. Such retraining is required both on-site in college campuses and industry plants, as well as in the home of the recipient. Wide bandwidth, bi-directional communications will allow a much more cost effective delivery of both forms of retraining. This can be expected to develop into a substantial business in its own right, and, more importantly, will facilitate the employment of our general labor pool within the increasingly efficient, flexible and competitive world environment.

Similarly, wide bandwidth communications will facilitate the delivery of third level education more equally among social and economic groups. Given the significant portion of the population which cannot readily pursue on-campus educational programs (for example, those who have low income and/or are single parents), the opportunity to pursue education from home represents a major benefit, one with considerable impact on the public good.

A long running and successful example of this at the university level can be found in Britain's Open University [2]. This institution was established in 1971 with a goal to provide higher educational access to adults who had, for any reason, missed their primary educational opportunity. Today, there are four schools at the undergraduate level offering programs in humanities, social sciences, education, science, technology and mathematics.

There are also postgraduate continuing education programs with an emphasis on technologies that include computer science, robotics and electronics. The Open University model first developed in Britain has served as a model for similar approaches in more than thirty countries. The opportunity for this service is materially enhanced by the availability of economical wideband communications.

It is also reasonable to expect that cooperation between educational institutions both within a region, and between regions, at educational levels ranging from elementary through post-graduate, will be significantly enhanced by wideband communications. These communications will allow for resource sharing and group cooperation to improve both the cost effectiveness and efficiency of education. For example, excellent teachers and professors can reach a wider audience, and scarce lab equipment will be demonstrated beyond the confines of its specific location.

Early examples of such cooperation include the National Technological University, university-level education with emphasis on continuing education, and the Project Jason [3] effort organized by Robert Ballard of the Deep Submergence Laboratory at Woods Hole Oceanographic Institute. This latter effort is targeted at primary school children, allowing them to participate by means of real time video links with scientists as they explore the depths of the Mediterranean Sea with robotic submersibles in archeological and geological research programs.

HEALTH CARE

While the U.S. currently enjoys the world's highest level of health technology, there are major problems in its administration. First, the cost of health care has become a staggeringly heavy burden on the Nation's economy. Second, there is a large segment of the population for whom care is not available.

Providing the capability for wide bandwidth communications among health care professionals, thereby facilitating teleconsultations, is a step toward extending the application of our health technology to a greater segment of the public.

While physicians currently consult by means of the telephone, the ability to share simultaneously diagnostic images, physiological data, patient histories, and even joint examinations through high quality audio, video and data sharing offers prospects of major improvements in the clinical field of teleconsulting, a rapidly expanding technique. [4]

SMALL BUSINESS USE

Small businesses play an increasingly important role in the Nation's economy, with most job creation coming from this segment. While small businesses have the inherent advantage that they can react quickly to market opportunities and can target rich markets effectively, they must become ever increasingly efficient in the receiving and disseminating of information about marketing, purchasing and sales - functions performed by dedicated private professionals in large businesses.

Wide bandwidth, bi-directional communications can be the basis for such resource sharing among small businesses, sharing that is timely and efficient. This sharing can help them maintain their competitive edge and with it their ability to generate jobs in the increasingly competitive world economy. In fact, given sufficiently flexible and affordable communications capabilities, groups of small businesses can work together collectively in order to fulfill the requirements of business opportunities as they arise, engendering opportunistic cooperation.

LARGE BUSINESS USES

A reciprocal of the opportunity for small businesses to combine their strengths is the opportunity for large businesses to decentralize their operations, thereby gaining the advantages associated with small businesses, while using the capabilities provided by wide bandwidth communications to retain their large businesses capabilities. Immediate opportunities can be seen in work-at-home and work-from-home jobs for sales and service personnel, as well as the sharing of various corporate functions such as legal support.

Both large and small businesses will lean towards a "virtual corporation" with a minimum of fixed infrastructure that can use seamless wide bandwidth communications and distributed computation to organize both flexibly and efficiently, to meet the ever changing needs of the marketplace. Tools which provide the infrastructure to allow the development of these organizations incrementally accommodate the development of our Nation as the economic powerhouse of the future. Because the capital costs of radio-based, wide-bandwidth, non-digital communications in the 27.5-29.5 GHz range are relatively low and are incurred only as the service is used, the CellularVision technology is the only one that can provide the Nation with these benefits.

Moreover, there are ancillary benefits to replacing face-to-face communications with wide bandwidth electronic delivery communications. For example, there will be reduced need for commuting to and from work, resulting in less traffic congestion, air pollution and use of non-renewable, imported, energy products. Similarly, the ability to work at or from home promises to ease the burden of child care, improving the quality of life for a large portion of the public.

INTERNET AND THE INFORMATION HIGHWAY

The Government sponsored Internet has been a phenomenal success in connecting the world's technical and scientific communities, thereby dramatically improving their productivity. While this system has been successful, it has mainly provided institutional access to communications capabilities and information sharing. By providing the capability